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Indian Standard

PERFORMANCE REQUIREMENTS AND METHODS OF TEST FOR WHEELS/RIMS FOR TRUCKS AND BUSES

Automotive Vehicles Sectional Committee, EDC 38; Tyres, Tubes and Rims Subcommittee, EDC 38 : 8 [Ref: Doc: EDC 38 (3022)]

1. Scope — Specifies laboratory test methods and performance requirements for evaluating certain essential strength characteristics of disc wheels intended for highway use on trucks, buses, trailers and multi-purpose passenger vehicles.

1.1 Failure criteria for the tests covered by this standard have also been specified.

2. General — Only fully processed new wheels/rims which are representative of wheels/rims intended for the vehicle shall be used for the tests. No wheel/rim shall be used for more than one test.

3. Tests — Following tests are covered:

a) Disc wheel dynamic cornering fatigue test, and

b) Disc wheel and demountable rim endurance test under dynamic radial load.

3.1 *Disc Wheel Dynamic Cornering Fatigue Test* — The dynamic cornering fatigue test shall be conducted by one of the alternative methods specified in **3.1.1**, **3.1.2** and **3.1.3**.

3.1.1 *Cornering fatigue test (90° loading method — alternative No. 1)*

3.1.1.1 *Equipment* — The test machine shall have a driven rotatable device whereby either the wheel rotates under the influence of a stationary bending moment or the wheel is stationary and is subject to a rotating bending moment (*see* Fig. 1).

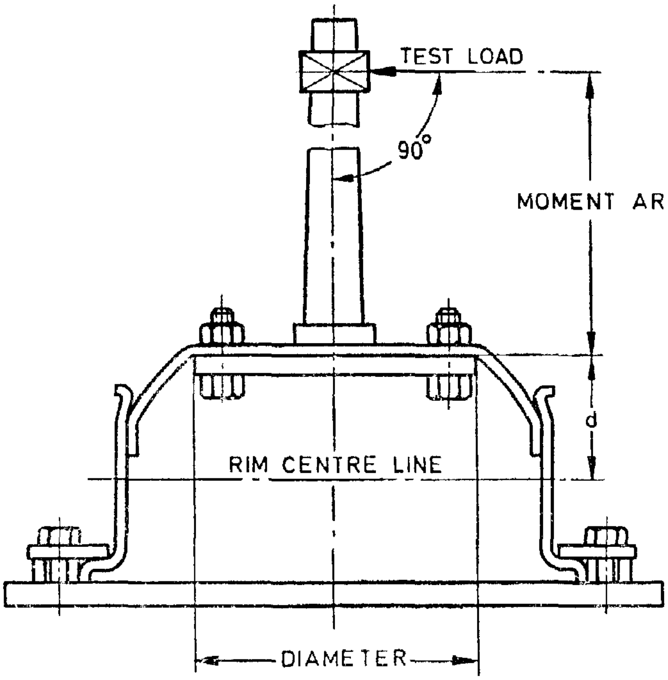

FIG. 1 CORNERING FATIGUE TEST — 90° LOADING METHOD (ALTERNATIVE NO. 1)

3.1.1.2 *Procedure*

a) *Preparation* — The rim of the wheel shall be adjusted and clamped securely to the test fixture. The face by which the wheel centre is supported on the testing machine shall have the same dimensional characteristics as the usual matching face used on the vehicle. The load arm and adapter assembly shall be attached to the mounting surfaces of the wheel using non-lubricated studs and nuts (or bolts), in good condition,

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representative of those used on the vehicle. The wheel fixing shall be assembled and tightened at the beginning of the test using the procedure as specified by the vehicle manufacturer or the wheel manufacturer. The mating surfaces of the test adaptor and wheel shall be free of excessive build up of paint, dirt or foreign matter. Wheel bolts or nuts may be retorqued during the test. The load system shall maintain the specified load within ±5 percent. The final clamped position of the wheel without load shall not exceed an eccentricity of 0·25 mm (TIR) normal to the point of loading.

b) *Bending moment application* — To impart a bending moment to the wheel, a force is applied parallel to plane of the mounting surface of the wheel at a specified distance (moment arm).

3.1.1.3 *Bending moment determination* — The bending moment M (force × moment arm) is given in newton metres, by the formula:

$$M = (\mu R + d) F \times S$$

where

μ = assumed coefficient of friction developed between tyre and road;
R = static loaded radius, in metres of the largest tyre to be used on the wheel as specified by the vehicle manufacturer;
d = inset or outset of the wheel in metres;
F = load rating of the wheel in newtons as specified by the wheel or vehicle manufacturer; and
S = accelerated test factor.

Note — For values of μ and S, refer to Table 1 (*see* Appendix A).

3.1.1.4 Failure ceriteria shall be:

a) inability of wheel to sustain load;
b) a fatigue crack penetrating through a section of the wheel; and
c) inability of wheel to withstand the number of test cycles given in Table 1 (*see* Appendix A).

3.1.2 *Cornering fatigue test (40° loading method — alternative No. 2)*

3.1.2.1 *Equipment* — The test machine shall have a driven rotatable device whereby either the wheel rotates under the influence of a stationary bending moment and axial load or the wheel is stationary and is subjected to a rotating bending moment and axial load (*see* Fig. 2).

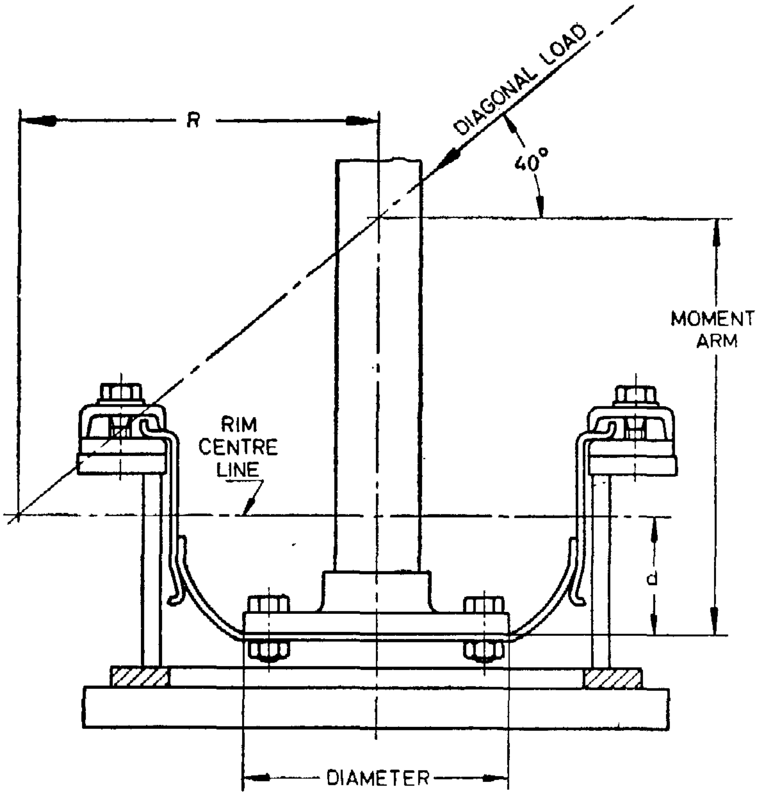


FIG. 2 CORNERING FATIGUE TEST — 40° LOADING METHOD (ALTERNATIVE NO. 2)

3.1.2.2 *Procedure*

a) *Preparation* — The rim flange of the wheel shall be clamped securely to the test fixture. The face by which the wheel centre is supported on the testing machine shall have the same dimensional characteristics as the usual matching face used on the vehicle. The load arm and adapter assembly shall be attached to the mounting surface of the wheel using non-lubricated studs and nuts (or bolts), in good condition, representative of those used on the vehicle. The wheel fixing shall be assembled and tightened at the beginning of the test using the procedure as specified by the vehicle manufacturer or the wheel manufacturer. The mating surfaces of the test adapter and wheel shall be free of excessive build-up of paint, dirt or foreign matter. Wheel nuts or bolts may be retorqued during the test. The load system shall maintain the load within ±5 percent. The final clamped position of the wheel without load shall not exceed on eccentricity of 0·25 mm (TIR), normal to the shaft axis at the point of loading.

b) *Bending moment application* — To impart a bending moment and axial load to the wheel, a force is applied at nominal angle of 40° from a plane through the centre of the rim at a specified distance (moment arm) as shown in Fig. 2.

3.1.2.3 *Test load and moment area determination* — The diagonal test load resultant D is given, in newtons, by the formula:

$$D = F \times S$$

where

F = load rating of the wheel specified by the wheel/vehicle manufacturer in newtons, and

S = accelerated test factor.

The moment arm (MA) is given, in metres, by the formula:

$$MA = R \tan 40^\circ + d$$

where

R = static loaded radius in metres of the largest type to be used on the wheel as specified by the vehicle manufacturer,

d = inset or outset of the wheel in metres, and

$\tan 40^\circ = 0{\cdot}84$.

Note — For values of S, refer to Table 2 (*see* Appendix A).

3.1.2.4 Failure criteria shall be:

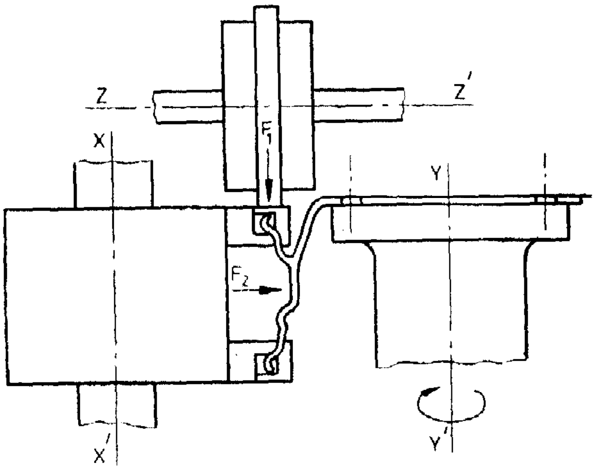
a) inability of wheel to sustain load,

b) a fatigue crack penetrating through a section of the wheel, and

c) inability of wheel to withstand number of test cycles given in Table 2 (*see* Appendix A).

3.1.3 *Cornering fatigue test* (*two-axis load method* — *alternative No. 3*)

3.1.3.1 *Equipment* — The test machine shall have a driven rotatable device whereby either the wheel rotates under the influence of a stationary bending moment, axial and radial load, or the wheel is subjected to a rotating bending moment, axial and radial load (*see* Fig. 3).



XX', YY', ZZ' in same plane.
$ZZ' \perp XX'$.
$XX' \parallel YY'$.

FIG. 3 CORNERING FATIGUE TEST — TWO-AXIS LOAD METHOD (ALTERNATIVE NO. 3)

3.1.3.2 *Procedure*

a) *Preparation* — The rim flange of the wheel shall be clamped securely to the test fixture. The face by which the wheel centre is supported on the testing machine shall have the same dimensional characteristics as the usual matching face used on the vehicle. The load arm and the adapter assembly shall be attached to the mounting surface of the wheel using non-lubricated studs and nuts (or bolts), in good condition, representative of those used on the vehicle. The wheel fixing shall be assembled and tightened at the beginning of the test using the procedure as specified by the vehicle manufacturer or the wheel manufacturer. The mating surfaces of the test adaptor and wheel shall be free of excessive build-up of paint, dirt or foreign matter. Wheel bolts or nuts may be retorqued during the test. The load system shall maintain the specified load within ± 5 percent.

b) *Bending moment, axial and radial load application* — To impart a bending moment, axial and radial load to the wheel two forces are applied, one radial and one axial. The radial load is applied at the centre line of the rim, perpendicular to the wheel axis. The axial load is applied to the rim flange, parallel to the wheel axis (*see* Fig. 3).

3.1.3.3 *Test load determination* — The axial test load F_1 and the radial test load F_2 are given, in newtons, by the formulae:

$$F_1 = F \times S_1$$
$$F_2 = F \times S_2$$

where

F = load rating of the wheel in newtons as specified by the wheel or vehicle manufacturer,

S_1 = accelerated test factor No. 1, and

S_2 = accelerated test factor No. 2.

Note — Values of S_1 and S_2 are under consideration.

3.1.3.4 Failure criteria shall be:

a) inability of wheel to sustain load, and

b) a fatigue crack penetrating through a section of the wheel.

3.2 *Disc Wheel and Demountable Rim Endurance Test under Dynamic Radial Load*

3.2.1 *Equipment* — The test machine shall be equipped with a means of imparting constant radial load as the wheel rotates. There are many means of imparting radial loads. The suggested equipment incorporates a driven rotatable drum set which presents a smooth surface wider than the loaded test tyre section width. The preferred diameter of the drum is 1 700 mm. The test wheel (single application) and tyre fixture shall provide loading normal to the surface of the drum and in line radially with the centre of the test wheel and the drum. The axes of the drum and test wheel shall be parallel.

3.2.2 *Procedure*

3.2.2.1 *Preparation* — Tyres selected for the test wheel shall be representative of the maximum load capacity tyre specified by the wheel or vehicle manufacturer. For disc wheels, the test adapter shall be representative of production hubs and studs and nuts representative of those specified for the wheel. The wheel nuts shall be torqued to the torque limits specified by the wheel or vehicle manufacturer for stud size and type of nut used. Nut torque values shall be checked and reset periodically during the course of the test in order to compensate for the 'wearing-in' of mating surfaces of nut and bolt holes. The mating surfaces of the test adaptor and wheel shall be free of excessive build-up of paint, dirt or foreign matter.

3.2.2.2 *Tyre test inflation pressures* — The test load and inflation pressure are based on wheel/ rim ratings. Test inflation pressures shown below are for information only:

Tyre Pressure at Usage Load kPa	*Tyre Test Pressure* kPa
Up to 310	450
320 to 450	550
460 to 580	690
590 to 720	900
730 to 830	1 000

The selected test inflation pressure and load shall be maintained within ± 5 precent.

3.2.2.3 *Force application* — A constant radial load shall be imparted to the wheel as the wheel rotates.

3.2.3 *Radial load determination* — The radial load F_r is given, in newtons, by the formula:

$$F_r = F \times K$$

where

F = load rating of the wheel/rim, in newtons, as specified by the wheel/rim manufacturer, and

K = accelerated test load factor.

Note — For values of K, refer to Table **3** (*see* Appendix A).

3.2.4 Failure criteria shall be:

a) inability of wheel to sustain load,

b) a fatigue crack penetrating through a section of the wheel, and

c) inability of wheel to withstand the number of test cycles given in Table 3 (*see* Appendix A).

APPENDIX A

[*Clauses* 3.1.1.3, 3.1.1.4 (c), 3.1.2.3, 3.1.2.4 (c), 3.2.3 *and* 3.2.4 (c)]

TEST FACTORS AND PERFORMANCE REQUIREMENTS

To permit a uniform application of the test methods specified, the test factors set forth in Tables 1, 2 and 3 shall be used when conducting the tests.

TABLE 1 TEST FACTORS FOR CORNERING FATIGUE TEST, ALTERNATIVE NO. 1, 90°LOADING METHOD AND PERFORMANCE REQUIREMENTS

[*Clauses* 3.1.1.3 *and* 3.1.1.4 (c)]

Disc Wheel Description						Performance Requirements
Material	Bolt Circle Diameter mm	Rim Diameter Designation	Inset or Outset mm	Accelerated Test Factor S	Coefficient of Friction μ	Min Cycle Life
Ferrous	Any bolt circle	13, 14, 15	Inset below 100 and all outset	1·60	0·7	18 000
Ferrous	Any bolt circle	16 and above*	Inset below 100 and all outset	1·33		30 000
Ferrous	Any bolt circle	Any diameter*	Inset 100 and above	1·10		60 000
Aluminium	(10 holes) 285·75 and larger	Any diameter*	All inset or outset	1·35		250 000

*Excluding rim diameter designation 17·5 and larger with rim width of 266·7 mm and wider (wide-base truck/bus wheels).

TABLE 2 TEST FACTORS FOR CORNERING FATIGUE TEST, ALTERNATIVE NO. 2 40°LOADING METHOD AND PERFORMANCE REQUIREMENTS

[*Clauses* 3.1.2.3 *and* 3.1.2.4 (c)]

Disc Wheel Description					**Performance Requirements**
Material	Bolt Circle Diameter mm	Rim Diameter Designation	Inset or Outset	Accelerated Test Factor *S*	Min Cycle Life
Ferrous	Below 285·75	16 and above	All	1·6	20 000
Ferrous*	222·25	15	All	1·6	20 000
Ferrous	Below 285·75 (except 222·25 bolt circle × 15 diameter as noted above)	Below 15	All	†	†
Ferrous	285·75 and greater	All	All	1·9	30 000

*Wheels used for low platform trailers.

†Use 90° loading method.

TABLE 3 TEST FACTORS FOR DYNAMIC RADIAL LOAD TEST AND PERFORMANCE REQUIREMENTS

[*Clauses* 3.2.3, *and* 3.2.4 (c)]

Disc Wheel Description					**Performance Requirements**
Material	Bolt Circle Diameter mm	Rim Diameter Designation	Inset or Outset	Accelerated Test Factor *K*	Min Cycle Life
Ferrous	Any bolt circle	13, 14, 15, 16 full drop centre	All	2·2	500 000
Ferrous	Any bolt circle	15, 16 semi-drop centre	All	2·2	500 000
Ferrous	Any bolt circle	16·5 — 17·5 full drop centre*	All	2·2†	500 000
				1·8†	1 000 000
Ferrous	Any bolt circle	15, 17, 18, 20, 22, 24 flat base 5° range rims	All	2·0†	500 000
				1·9†	600 000
				1·8†	700 000
				1·7†	850 000
				1·6†	1 000 000
Ferrous	Any bolt circle	19·5 — 22·5 — 24·5 drop centre‡	All	2·0†	500 000
				1·9†	600 000
				1·8†	700 000
				1·7†	850 000
				1·6†	1 000 000
Aluminium	(10 holes) 285·75 and larger	Any diameter	All	2·0§	1 000 000

*(248 mm) rim width and narrower.

†Use load factor and corresponding cycle life to achieve adequate tyre life to run the test. Cycle life will increase as the accelerated test factor *K* decreases where multi-test factors are listed.

‡Exclude 267 mm rim width and wider with rim diameter designation of 19·5 and 22·5.

§Use load factor and corresponding cycle life to achieve adequete tyre and related wheel/rim component life to run the test.

EXPLANATORY NOTE

While preparing this standard, considerable assistance has been derived from the following publications:

ISO 3894-1977 Road vehicles — Truck — Wheel/rims — Test methods. International Organization for Standardization, and

SAEJ 267a Wheels/rims — Trucks — Test procedure and performance requirements. Society of Automotive Engineers (Inc), USA.

Accelerated test factors for cornering fatigue test (two-axis) load method (alternative No. 3) are under study and will be included in the standard at a later date.

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